Boundary Layer Processes in the Surf Zone and Inner Shelf in CROSSTEX and MISO

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LONG TERM GOALS

Long term goals are to observe and model turbulent stresses in the bottom boundary layer (BBL) arising from wave forcing and low frequency currents, and the resulting sediment transport, and bedform evolution in the inner shelf and surf zone. The presence of mobile sandy beds across continental shelves and surf zones results in complex interactions and strong feedbacks between fluid motion in the bottom boundary layer and sediment movement both as bed load and suspended sediment flux. A primary goal is to develop parameterizations of the formation of different bedform types to different aspects of wave and current forcing. A second goal is better understand and model changes in effective bed roughness and BBL wave dissipation in response to these evolving bedforms.

OBJECTIVES

A primary scientific objective of this project is to measure turbulent stresses, shear and sediment fluxes in the bottom boundary layer in both inner shelf and surf zone field experiments and large scale tank experiments. The field observations represent the more complex superposition of several forcing factors including cross-shore and long-shore low frequency currents, and broadbanded wave forcing. These long term (months to years) timeseries provide a range of these forcing parameters. Inner shelf field BBL observations from the 12m depth cabled MISO observatory in Monterey bay and surfzone measurements from RIPEX and NCEX are being used in these analyses. Data sets from these field programs are being complimented by measurements using the same instrument systems in the large scale wave flume at the OSU Hinsdale Large Scale Wave Flume during CROSSTEX in the fall of 2005. This provided an opportunity to have controlled, programmable wave conditions with negligible longshore and crosshore mean currents, providing more constrained forcing conditions than achievable in the field, and the opportunity to close sediment transport budgets. The 104m long wave flume was used to produce sets of TMA spectrum waves with varying bandwidths with amplitudes up to 1.6m at 4second period, and was filled with beach sand to form a beach for this series of experiments.

APPROACH

A four beam Bistatic Coherent Doppler Velocity Profiler (BCDVP) developed in my research group at NPS (Stanton 1996, 2001, 2005a) has been used to acquire a three month BBL data set at the MISO inner shelf site, and month-long surfzone measurements in Monterey Bay and Blacks Beach. Bedform maps were measured every 15 minutes using a scanned altimeter with 2cm horizontal and 0.2cm

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14. ABSTRACT
Long term goals are to observe and model turbulent stresses in the bottom boundary layer (BBL) arising from wave forcing and low frequency currents, and the resulting sediment transport, and bedform evolution in the inner shelf and surf zone. The presence of mobile sandy beds across continental shelves and surf zones results in complex interactions and strong feedbacks between fluid motion in the bottom boundary layer and sediment movement both as bed load and suspended sediment flux. A primary goal is to develop parameterizations of the formation of different bedform types to different aspects of wave and current forcing. A second goal is better understand and model changes in effective bed roughness and BBL wave dissipation in response to these evolving bedforms.

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vertical resolution in a 1m square area surrounding the 0.8m high profile of 1cm binned 3 component velocity vectors measured by the BCDV. A 5 beam version of the BCDV, that provided additional symmetry in the stress calculations and redundant velocity component sampling, was deployed for a 3 week period in the OSU flume s during the CROSSTEX. A new scanned laser imaging system was used to measure small scale bedforms and 2D sediment suspension profiles to 2mm scales during this experiment. Most wave runs during CROSSTEX were 10 – 20 minute repeated sequences of either narrow or broadband TMA waves with slowly increasing amplitude, providing a hierarchy of forcing strength and bed stress during which the suspended sediment and bedform evolution were measured. Narrow band cases were limited in duration to prevent strong bar formations, and interspersed with longer wide-band runs to restore uniform beach conditions.

Figure 1. A view of deployed instruments looking down the sand beach (at "low tide") within the OSU Large wave Flume during CROSSTEX. The left spar supported the 5 beam BCDV velocity and suspended sediment profiler, the acoustic scanned altimeter, and the scanned laser. The right spar suspended a reference ADV current sensor and camera that imaged the bedforms and scanned laser patterns.

WORK COMPLETED

A programmable scanned laser synchronized to a digital video imaging system was completed and deployed during CROSSTEX. The suite of BBL instruments described above were successfully deployed for a 3 week set of experiments just offshore from the surf zone during CROSSTEX, exploiting the repeatable, programmable wave conditions that allow bed evolution and hydrodynamic forcing to be studied in great detail. The quasi periodic wave trains also have allowed phase averaging techniques to be used in turbulence profiles estimates. This work was closely coordinated with Diane Foster who was using a near-bed Particle Imaging Velocimetry system at the same cross-shore

location. This co-location is providing an excellent opportunity to compare turbulence measurements made by these two different velocity measurement techniques.

RESULTS

Techniques to estimate stress profiles in combined mean current and oscillatory flows from field data with data dropouts due to bubble clouds and other scatterer effects have been developed for the inner shelf and nearshore data sets (Stanton 2005a). Scanned altimeter data and wave forcing from a year-long timeseries at the MISO site have been processed and analyzed to assess the bed response to the range of forcing at that site (Stanton 2005b). An analysis of NCEX nearshore data is focusing on bed accretion events associated with rip currents near the BBL measurement array (Stanton 2004). This analysis is being completed with assessing suspended sediment fluxes and comparing them with accretion events measured by high resolution KGPS surveys and video imagery. The CROSSTEX BCDV velocity and suspended sediment timeseries are currently being processed to extract clean data sets to share with other CROSSTEX investigators. Both X/Y altimeter and laser imaged bedforms are being processed, and compared. These controlled wave, low current condition observations in the tank are being shared with colleagues who are using DUNE2 and LES/DNS models to expand the single profile hydrodynamic measurements from the BCDV, as well as direct assessment of wave stress / bed response analyses with Bill Shaw in our research group.

IMPACTS / APPLICATIONS

Improved understanding of wave and current forcing and bedform response are critical to improving high resolution wave models for coastal areas. Bedform prediction models are being developed with these data sets. The detailed hydrodrodynmaic measurements through the mean current and wave boundary layers provide estimates of wave work rates over the evolving bedforms, allowing parameterizations for these complex processes to be developed.

RELATED PROJECTS

This research is coordinated with the NCEX nearshore canyon project, and the Ripples DRI. Analysis of the CROSSTEX data sets is underway in collaboration with Diane Foster, a Danish Technical University student Jennifer Ogrodnick, and many other CROSSTEX colleagues.

TRANSITIONS

Improved ripple / BBL parameterizations will be transitioned into high resolution nearshore models including Deltf3D and ongoing model community models.

REFERENCES

Stanton, T. P., 1996. Probing ocean wave boundary layers with a hybrid bistatic / monostatic Coherent Acoustic Doppler Profiler. Proceedings of the Microstructure Sensors in the Ocean Workshop, Mt Hood, October 1996.

Stanton, T. P., 2001. A Turbulence-Resolving Coherent Acoustic Sediment Flux Probe Device and Method For Using. US Patent 6,262,942, issued 17 July 2001.

Stanton, T. P., E. B. Thornton, 2004. The Influence of Breaking Waves on the Bottom Boundary Layer Within the Surf Zone. Ocean Sciences meeting, Portland Oregon, *EOS Transactions* January 2004.

Stanton, T. P., 2005a. High Resolution Acoustic Doppler Profiling of Velocity, Reynolds stresses and Sediment Concentration in Wave Forced Boundary Layers. Submitted to J. Atmos. and Oceanic Technol.

Stanton, T. P. 2005b. Wave Forcing and Bed Morphology Response at the MISO Inner Shelf Observatory. Submitted to JGR.

Website:http://www.oc.nps.navy.mil/~stanton/crosstex/